

The Genus *Popillia* with Its Natural Enemies in the Orient (Col.).

BY J. F. ILLINGWORTH.

(Presented at the meeting of February 5, 1925.)

In this paper I wish to briefly review the work as carried on in the Orient by the United States Department of Agriculture in their search for natural enemies of *Popillia japonica* Newm. Though this species is evidently confined to Japan, the Genus *Popillia* is widely distributed. Recorded species are very numerous, being in their order of abundance from India, China, Korea, Africa, Japan, Mexico, Manchuria, etc.

Clausen and King (1924)* have already given an excellent preliminary report on the work accomplished in Japan and Korea. The exceedingly effective tachinid parasite which they found in northern Japan was named *Centeter cinerea* by Doctor Aldrich (1923). This fly practically wipes out the beetles during the years of their abundance, i. e., alternate years, parasitizing more than 99 per cent of the females. The eggs are firmly glued to the dorsum of the thorax. Hatching, the maggots at once make their way through the hard chitin, quickly putting an end to the activities of the beetle. Since the maggot devours most of the internal anatomy, the host dies in about five days. The maggot then pupates within the empty, hard shell of the beetle, which makes it very convenient for handling and shipping them during their long dormant period. They do not emerge as flies until the following spring.

Hundreds of thousands of these parasitized beetles have been collected in northern Japan, and shipped to the laboratory at Riverton, New Jersey, where the issuing flies were liberated. A few parasitized beetles were found in the field near Riverton during the summer of 1923, as reported by Mr. Smith (1924). The past season (1924) gave further very encouraging evidence, for Mr. Smith wrote that beetles with eggs attached to the thorax had been collected in considerable numbers and over a wide area, far removed from the point of original liberations of the flies.

Proc. Haw. Ent. Soc., VI, No. 2, July, 1926.

* Figures in parentheses refer to bibliography.

Another, though less effective parasite of the adult beetles, is the yellow tachinid, found at Yokohama. Doctor Aldrich (1923) determined this as *Ochromeigenia ornioides* Towns. This fly is a most elusive creature. It is active only at night. We experienced the greatest difficulty in trying to learn something of its habits, and were unable to discover just how it parasitized the beetles. For this investigation we built a large screen cage, covering native food-plants of the beetles. In this we were able to observe that the flies remained absolutely motionless during the day, sitting wherever they chanced to be, either on the foliage, or on the screening of the walls. As soon as dusk approached, however, they became exceedingly active, running around the beetles and touching them with their antennae. Where the beetles were on the screen sides of the cage, the activities of the flies could be more easily followed in the semidarkness by getting down, so as to use the sky as a background. Under such conditions, I could see that the fly, with ovipositor extended and curved forward, ran quickly over the back of the beetle. This insect evidently was fully alive to its danger, for it remonstrated vigorously by kicking its hind legs over its back. The movement of the parasite was so rapid, however, and the light so poor, that I was unable to make out just when parasitism took place. At any rate, nothing was left on the surface of the beetle, for I examined such specimens by lamplight. Yet flies developed later from these beetles, demonstrating that the act had been accomplished.

Dissection of these yellow flies showed that they are viviparous—the eggs hatched within their body—so they evidently deposit the active larva upon the beetle. Hence, we may conclude that the maggot is possibly tucked under the wing covers, which are slightly raised during the struggle of the beetle to free itself of the troublesome parasite. At any rate, the maggot is quickly at work eating out the vitals of the host. Under most favorable field conditions, in the vicinity of Yokohama, about 35 per cent of the pest succumbed to this parasite.

Japanese parasites of the grubs of *Popillia*, so far discovered, are not as promising as the above. These are scoliid wasps belonging to the Genus *Tiphia*, and a dexiid fly (*Prosenia siberita* Fabr.). This latter insect was exceedingly abundant in many

parts of Hokkaido during August, 1923, when making a hurried scouting trip of that island. On this trip we found the *Popillia* beetles very scarce, but these natural enemies of the grubs were much in evidence. At Piuka, in northern Hokkaido, we also found scoliid wasps, belonging to the Genus *Campsomeris*, swarming over grub-infested soil along a railway embankment. Yet we were not able to devote sufficient time to digging to determine whether they were using *Popillia* for a host or not.

Both *Tiphia* and *Campsomeris* wasps were found also in Korea, parasitizing the grubs of related *Popillia* and *Anomala* beetles. A second species of dextiid was also found there breeding on these grubs.

In November, 1923, I went over to China to make a study of the natural enemies of the related species of *Popillia*, which are rather abundant in that country. The fact that these beetles are so prolific there would suggest that parasites are few in the country. In the valley of the Yangtze River we found the following, named in the order of abundance: *Popillia atrocoerulea* Bates, *P. indigonacea* Mots., *P. cyanae* Hope, and *P. quadriguttata* Fabr. We hired collectors to bring these in by the tens of thousands. Each individual beetle was examined for external parasites, and, furthermore, all those that died within a week after collecting were kept. From all of these, only two parasites emerged, and they were the yellow tachinids, like we found at Yokohama.

Farther south, at Foochow, *P. cyanae* and *P. quadriguttata* were the very abundant species, while we got a few of the subtropical *P. marginicollis* Hope. Here, again, no parasites of the adult beetles were discovered. Toads and other predators, however, were much in evidence, feeding on this easily procured food.

Scoliid wasps are considerably in evidence in China. At least three species of these were reared on *Popillia* grubs at our stations at Chinkiang, Nanking, and Hangchow. At the first of the above stations we bred out a species of *Campsomeris* wasp, but the life-cycle was so short that it could pass through several generations each season. Hence, it would probably require several hosts. A small species of *Tiphia* was fairly common, and very peculiar in that it deposited a black egg on the venter, just

behind the legs of the paralyzed grub. A larger *Tiphia* placed a white egg on the dorsum of the thorax of its host. These two most promising species were bred out in considerable numbers, the cocoons being easily forwarded to Riverton for liberation.

During this work in the Orient since its inception in 1920, more than a dozen true insect parasites of the Genus *Popillia* have been found. Several of them have been shipped in considerable numbers to the New Jersey laboratory. Great hopes are based upon the known efficiency of the tachinid, *Centeter cinerea* Ald. Yet the investigation is now being extended as far as India, and will be kept up until such time as the pest ceases to be a menace in the infested region of the eastern United States.

BIBLIOGRAPHY

1920. Davis, J. J., The Green Japanese Beetle: N. J. Dept. Agric. Circ., 30, pp. 33.
1922. Hadley, C. H., The Japanese Beetle: N. J. Dept. Agric. Circ., 46, pp. 20.
1923. Aldrich, J. M., Two Asiatic Muscoid Flies parasitic upon the so-called Japanese Beetle: Proc. U. S. Nat. Mus., Vol. 63, No. 2474, pp. 1-4.
1924. Hadley, C. H., The Japanese Beetle in Pennsylvania: Bull. Penn. Dept. Agric., No. 390, pp. 19.
1924. Clausen, C. P., and King, J. L., A Preliminary Report on the Foreign Parasites of *Popillia japonica*: Journ. Econ. Ent., Vol. 17, pp. 76-79.
1924. Smith, L. B., The Japanese Beetle Status in 1923: Journ. Econ. Ent., Vol. 17, pp. 107-111.
1924. Rohwer, S. A., Descriptions of Three Species of *Tiphia* Parasitic on *Popillia japonica* (Hymenoptera): Proc. Ent. Soc. Washington, Vol. 26, No. 4, April 21, pp. 87-92.